



TDX CONSTRUCTION CORPORATION

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June 17, 2003

Dormitory Authority State of New York
55 Lexington Avenue
New York, NY 10010

Attn: Wayne Markowitz
RE: Baruch College – Site "B"
Terrazzo Flooring System

Gentlemen:

This document is a summarization of the three (3) different firms that conducted detailed investigations and analyses of the failure(s) to the Terrazzo Flooring Systems, as well as TDX's sounding test.

A independent testing agency, Testwell Laboratories, Inc., conducted extensive field surveys, took core samples, and documented their findings in reports dated March 5 and April 15, 2003. The National Terrazzo & Mosaic Association, Inc., conducted a field survey on April 9th and stated their findings in an Inspection Report submitted on April 28, 2003. Niagara Research Associates, hired by the subcontractor, Crocetti Flooring, Inc., submitted their inspection report, dated April 8, 2003.

I HISTORY/BACKGROUND:

The following is a description of the actual installation of the epoxy terrazzo activity, as well as the events and process which led to the installation of the underlayment.

The Structural steel beams and trusses were designed with specific cambers to account for anticipated deflections in the steel due to the load on the completed steel framing. These cambers did not come out completely under the load, which led to the difference in elevations of the structural elements as related to theoretical. A minimum concrete coverage of 3-1/4" on the metal decking was required to maintain structural integrity, as well as to attain the proper coverage over shear studs, conduits and other embedded items. (See RFI Nos. CM-046, CM-051, CM-059 & CM-063, Exhibit 'A'). In all four RFIs the engineer responded to "maintain slab thickness in lieu of floor elevations" with each floor. This produced a concrete finish which followed the contours of the metal deck, and "light" floor framing members, which deflected as the concrete was placed.

This also created irregular contours in the flatness of the slab, and also caused finished floor elevations to be out of tolerance. (See RFI Nos. CM-046, CM-051, CM-059 & CM-063, Exhibit 'A'). Subsequently, the architect issued revised slab tolerances for each finish floor material. In areas of terrazzo floor, the architect would not accept any tolerances that were beyond 1/4" over 10 feet in any direction (see Exhibit 'B').

In the memorandum, dated November 8, 1999, the architect states: "The following criteria shall be used for slab tolerances for each finish floor material. Where slabs are beyond these tolerances, flash-patch material should be used to level the slabs prior to finish installation. Terrazzo 1/4" over 10 feet." Therefore, as per the direction of the RFI, the contractor was instructed to use flash-patching to fill in all the low spots in the structural slab and scarify some of the high spots. Approximately 81,000 SF of the terrazzo areas required the underlayment to meet the architect's revised requirements. As a result of this, Trataros was requested (TDX letter of January 13, 2000, see Exhibit 'C-1') to submit a proposal for floor-leveling work beyond the scope of the contract. Trataros submitted a proposal on March 21, 2000 (see Exhibit 'C-2'). The scope of this proposal was based on a thickness of 3/8" over an area of 100,000 S.F. A change order (see Exhibit 'C-3') for the floor-leveling in the amount \$853,000 was signed on April 16, 2000, by Trataros. Trataros submitted Conflow as the proposed floor-leveling system on April 7, 2000, to be used as the underlayment for the terrazzo floor (see Exhibit 'D'). The submittal was subsequently reviewed by the architect, KPF, and returned to Trataros on April 14, 2000, approved by KPF. (See Exhibit 'E').

Trataros Subcontractor, Bartec prepared the floors to receive the installation of the Conflow, and then mixed and placed Conflow in areas where needed. The installation of floor leveling throughout the building was reviewed at the biweekly job meetings and noted in the meeting minutes (see Exhibit 'F').

Trataros submitted and received the architect's approval for the Epoxy Terrazzo Flooring System as manufactured by TEC (see Exhibit 'G'). TEC is one of the specified manufacturers of the epoxy terrazzo.

Trataros was required to remove all curing compounds and other substances that would interfere with the proper bonding of the epoxy terrazzo. Trataros' subcontractors, Bartec and Crocetti sanded the concrete floors prior to installation of the epoxy floor or flash patching of the concrete floor to meet the leveling criteria established by the Architect. (See Exhibits 'H' & 'I').

Bartec and Crocetti are responsible to properly prepare the substrate to receive their product since according to Specification Section 03551, paragraph 3.01 B (see Exhibit 'J'), for "Cementitious Floor Leveling," and Specification Section 09420, paragraph 3.01 B (see Exhibit 'K') for "Epoxy Terrazzo," state that the contractor shall "Examine surfaces and conditions to which this work is to be attached and notify the Architect if conditions or surfaces exist which are detrimental to the proper and expeditious installation of the work." No notification was ever given by either contractor that there was a problem with existing surfaces. It also states in the above specification sections that the start of the work indicates acceptance of the existing surfaces to perform the work as specified.

II TESTWELL REPORT NO. 1 – DATED MARCH 5, 2003

1 Preliminary History:

Testwell's findings reported that the concrete slabs had been cured in excess of the contract requirements of twenty-eight (28) days. The terrazzo system that was installed was placed approximately one (1) year ago "under closed construction conditions with climate control already in place." The report also found that the substrate had been scarified or was "treated with one or more layers of self-leveling flooring underlayment (Conflow)." The report further states that the substrate was coated with a "roll-on epoxy membrane (FlexGuard by TEC), and that the zinc strips were placed on a gridwork adhered to the membrane. The terrazzo was mixed and placed in the field, and when cured the system was ground smoothed and polished, with "no small-scale imperfections."

Finally, the report noted that the "debonding" condition appeared after installation with a curling of the terrazzo at the zinc strips. Tapping tests for "hollow spots" indicated that the center of the terrazzo segments were adhering and still held a strong bond, and that the hollow spots were found to be at the outer edges of where the zinc strips had been installed and at their intersections in the gridwork in most instances.

2 Field Observations:

Testwell's "field observations" noted that in "some locations (1G and 1N) a deep scarification of the hardened slab was performed." While in other areas "fine scouring" was evident. And still in other locations, "one or more layers of self-leveling compound were placed on the structural slab." In essence, the epoxy membrane terrazzo flooring system was placed on top of different subsurface conditions, of which approximately 81,000 SF of the self-leveling compound out of a contract total of 134,000 SF of the epoxy membrane terrazzo, or sixty (60%) percent of the areas received floor leveling.

Other observations include "convex curlings" in the debonding of individual terrazzo sections, that there is "no pattern" to the debonding in relation to locations of doors and hallways, that the probe failures occur between the epoxy membrane and the substrate, that no significant fractures other than the "alligator scales" was detected, and that some "salt deposits" were detected along the exposed substrate at the zinc strip locations."

3 Preliminary Conclusions

Testwell's "preliminary conclusions" stated that the failures are confined to within the terrazzo segments and therefore is "limited to the flooring application and not larger scale movements or failures of the underlying structural slab." They noted that the failure usually shows as a "convex curling" and an "ovate pattern" of debonding.

Testwell states that the debonding is a direct result of a failure between the epoxy membrane and the substrate "regardless of whether the substrate is lightweight concrete or self-leveling compound," and that the debonding had separated with "no residual epoxy membrane adherent to the substrate even where scarified."

Testwell noted that regarding other observations, there appeared to be some "evidence of residues below the epoxy membrane" which needs to be further analyzed. Incomplete cleaning or poor preparation of the substrate "may be responsible for a weak epoxy bond," as there were areas where the concrete slab was scarified but the membrane didn't adhere to the rough grooves. As far as the material, it looked like it was applied consistent to the manufacturer's recommendations. While the "alligator texture" is hard to pinpoint in how it relates to shrinkage of the material.

III TESTWELL REPORT NO. 2 – DATED APRIL 15, 2003

"PETROGRAPHIC INVESTIGATION OF A DEBONDED TERRAZZO FLOORING SYSTEM"

1 INTRODUCTION

Testwell Laboratories' Petrographer, John J. Walsh, conducted a petrographic examination that focused on three (3) core samples of the terrazzo flooring system and the substrate below, which were recovered in concert with TDX field personnel on March 21, 2003. The purpose of the examination was to check on defects and deformations in the bond between the epoxy membrane of the terrazzo and the concrete or self-leveling compound, and surface failures due to shrinkage and "alligator texture."

The sample cores were taken as followed: Core No. 1 at Ground Floor over concrete in the corridor "not exhibiting a debonding condition. Core No. 2 at 2nd Floor where terrazzo overlay Conflow self-leveling compound and showed "alligator texture." Core No. 3 at the 2nd Floor where the terrazzo overlay Conflow self-leveling compound and "debondings are noted locally."

2 SUMMARY STATEMENT

The "alligator texture" analyzed in Core No. 2 revealed a failure due to tensile cracks, and "possibly related to settlement of some fine aggregate material with the terrazzo layer.

Mr. Walsh states that debonding is not related to the surface "alligator texture," as the failures are due to separate causes. He goes on to state that the "weakest bond in the entire flooring system appears to be in the upper surfaces of Conflow lifts." Mr. Walsh states this was caused by water segregating from the Conflow components, which in most cases was directly below the epoxy membrane. Core No. 1 showed evidence of "incipient delamination caused by overworking of the air-entrained concrete surface."

3 METHOD OF EXAMINATION

Testwell's petrographic examination "was conducted in accordance with the standard practices contained in ASTM C856: Standard Practice for the Petrographic Examination of Hardened Concrete." This included visual examination of the core samples, the use of a stereoscopic microscope, solution tests and the use of polarized light microscopes. These tools helped

determine some theories on the root causes why the material failed by checking on the "epoxy impregnation to highlight cracks, voids and capillary pores."

4 FIELD OBSERVATION AND INTERPRETATION OF SUMMARY

This is a follow up to the "preliminary site investigation report" dated March 5, 2003. The gist of the seven (7) bullet points can be found in the first report covering the following:

1. The placement of the substrate concrete slab, the self-leveling compound, the epoxy membrane and the zinc strips and terrazzo flooring system. Nothing new was added from the initial report.
2. This describes the look and type—"concave curlings"—of the debonding at the zinc strips. Nothing new was added from the initial report.
3. New observation: "The large-scale pattern of failure is essentially random with no apparent structural control. Debondings were witnessed at the basement level and 1st, 2nd, 7th and 12th floors."
4. Statement on residue present between the substrate and the epoxy membrane; rarely is there epoxy residue found on the substrate.
5. All contacts within the terrazzo flooring system are found to be intact. There were no visual observations of "significant vertically oriented fractures are detected in the main body of the terrazzo."
6. Some indication of failure between the slab and self-leveling flooring bond is noted as well as failure between lifts of Conflow."
7. The "alligator texture" repeats itself. Nothing new was added from the initial report.

5 BRIEF DESCRIPTION OF FIELD SAMPLES (COLLECTED BY TDX)

On March 4th, Testwell collected six (6) samples from seven probes. Some relevant information was found on the debonded sides of the samples. *Samples 1G and 1N*: Both samples were taken of terrazzo over scarified concrete. It goes on to describe that the "debonding occurs between the epoxy membrane and the underlying concrete substrate." Residue has been detected on some of the concrete fragments—large pieces pulled from the floor. The residue is a "sticky translucent" film. It was sampled and tests indicate the "presence of styrene acrylate" in the residue. "This compound is a common ingredient in concrete sealants."

Samples B1 and 2E: Both samples were taken from terrazzo over Conflow. The report states that the debonding occurs between the substrate and the epoxy membrane, and that the same "sticky" residue was found.

Sample 2W: This sample was taken from terrazzo over Conflow. The debonding occurs at the same location, but it does so "cleanly between the two layers."

Sample 12: This sample was taken from terrazzo over two (2) lifts of Conflow. Not only does the debonding occur between the epoxy membrane and the Conflow substrate, but it also happens

between the two (2) lifts of Conflow, and the bottom layer of Conflow and the concrete slab. "The upper lift of Conflow exhibits segregation of aggregate and the lower lift exhibits no aggregate at all. In both lifts, there appears to be a smooth gradation of color and material coarseness up through the lift." While "the debonding surfaces superficially appear to be composed of a primer layer."

6 CORE LAYER DIMENSIONS

Testwell Laboratories' John Walsh explains the thickness of the terrazzo layers and epoxy membranes, as well as other attributes of the samples that were taken and tested on. This section is more for showing the parameters of the samples than revealing any specific observation.

7 PETROGRAPHIC DATA

Here Testwell explains the testing procedures and breakdown of compounds for the Terrazzo Layers, Epoxy Membrane Layers, Conflow Layers, and the Concrete Layers. In the Terrazzo Layers, the "alligator texture" is discussed along with its deformation of physical characteristics. Delaminations are discussed in the Epoxy Membrane layers, while a breakdown of physical properties and compounds are noted in the Conflow Layers. Finally, an "incipient delamination is observed two to three millimeters below the concrete surface and no air-entrainment is present above the failure" in the Concrete Layers.

8 CONCLUSIONS (TESTWELL LABORATORIES)

"Alligator Texture": Most of these fine cracks do not penetrate below the surface of the terrazzo. Mr. Walsh reports: "there could be a correlation between the occurrence of 'alligating' and within the terrazzo layer. Also, the alligating occurs at the edges of the zinc strip on the terrazzo." The final statement states there is no correlation between the alligator texture and the debonding below the epoxy membrane.

"Terrazzo System": Testwell describes the scope of the study, what it included and did not include with respect to testing and "finishing tolerances" of the installed terrazzo. "With the exception of designed vertical separation between the terrazzo and the zinc strips, no debonding failures are noted within the system." Mr. Walsh also states that they did not detect "corrosion or other chemical deterioration of the zinc strips." He also states that he does not know what is the cause of the "shrinkage." Mr. Walsh further states that "expansion deformation," which would develop a crown in the center of the terrazzo segment, is not responsible for the shrinkage of material at the edges along the zinc strips.

"Self-Leveling Material": Testwell observed two (2) kinds of "crack structure" exist within the Conflow. The first, "is a polygonal hairline shrinkage structure that is essentially vertical." The cracks predate the debonding between the Conflow lifts. The second type of crack is "plumose structure" along the debonded surfaces. This type is defined as "by very finely spaced echelon tensile cracks that join to form a single tension crack. This structure likely reflects the actual debonding event responding to an essentially vertical tensile stress acting across the Conflow lift."

"Concrete": Testwell discusses the widespread nature of the debonding throughout the building, and that the sampling "exposure" was small by comparison.

"Comments on Repairs": Testwell does not state a complete method or solution to repairing the terrazzo flooring system, due to liability issues.

IV NTMA ON-SITE INSPECTION REPORT- DATED APRIL 17, 2003

1 THE PROBLEM

The National Terrazzo & Mosaic Association, Inc., (NTMA), conducted a site visit to analyze and write an inspection report regarding the condition of the terrazzo floor. The representative from the NTMA was Mr. Wayne T. Grazzini, President of WT Grazzini Terrazzo and Tile, Inc. Mr. Grazzini evaluated the failure of the epoxy membrane debonding from the substrate, especially beneath the zinc strips, the shrinkage of terrazzo material at the zinc strips, and the "alligator texture."

2 INSPECTION

A pre-inspection meeting was held to discuss the issues with the NTMA's Mr. Grazzini explaining that he came to "determine adherence to NTMA Guidelines." The NTMA inspector viewed samples taken from the field, and then discussed the installation methods done by the terrazzo flooring subcontractor, GM Crocetti, Inc.

Mr. Grazzini inspected the floors which he led a guided tour of the failed locations as they covered all floors from 14th down thru B-3 Basement Level. He noted that the "adhesion problem appeared to be more pronounced on floors 13 down through the street level." The NTMA inspector also pointed out areas where the "alligating" of the terrazzo finish were more prevalent in the lobbies and in front of the elevator cabs.

3 EVALUATION

The NTMA stated that the terrazzo finish was "completed in a manner which would generally meet NTMA Guidelines. The NTMA also stated that the alligating took place after the completion of the terrazzo installation. Other observations noted that the terrazzo appeared to be bonded to the epoxy membrane "in all visible cases," that the membrane wasn't fully bonded to the substrate below, that the underlayment showed signs of flakes and cracks, and "exhibits immediate deterioration in the presence of moisture." Finally, the NTMA states: "The underlayment does not appear to be of a type that would meet NTMA requirements."

The manufacturer's representative, TEC, was contacted by TDX to review problems being encountered at the site. TEC forwarded product data (see Exhibit 'L'). This specification section was not originally submitted, and was not part of the contract documents. However, this specification section includes information which may be relevant to the terrazzo problem.

Subsection 'B' reads: "The Architect and General Contractor shall be advised of any unsatisfactory conditions and work shall not proceed until the necessary corrections are made." Under Section 3.02 "Installation," Subsection 'A-1' "Substrate" reads: "Substrates shall be prepared to receive terrazzo in accordance with recommendations by TEC Specialty Products, Inc." The contractor never advised TDX that there was a problem with the substrate.

On May 13, 2003, TDX received a letter from TEC Specialty Products, Inc., the manufacturer of the Epoxy Terrazzo flooring system. TEC's Mike L. Cichorski, technical service specialist, stated: "We agree with the recommendation of the National Terrazzo and Mosaic Association that fill below an Epoxy Terrazzo topping should be an epoxy/silica sand mortar."

TDX later checked with Mr. Grazzini from the NTMA as to what constitutes an acceptable underlayment for terrazzo. TDX was later informed that there are no written guidelines from NTMA as to a standard underlayment, but rather, it is up to each manufacturer to approve an acceptable underlayment. It is noted that TDX received a memorandum, dated May 6, 2003, (see Exhibit 'M'), from the terrazzo manufacturer, TEC, stating that they will accept an "epoxy/silica sand mortar" underlayment. Neither TDX, KPF nor DASNY was made aware of this statement prior to this time from Trataros, Crocetti, or TEC. As previously noted, Trataros submitted Conflow through their floor-leveling subcontractor, Bartec, for use as an underlayment (see Exhibit 'D').

4 OPINION

The NTMA states the failure points to a deterioration of the underlayment. The NTMA inspector, Mr. Grazzini, further states that "the failure may have been further aggravated by deflection caused by loading of the 'Post Tension' concrete..." And he also stresses: "the NTMA recommends that where epoxy terrazzo is to be installed 'curing compounds of any type are not to be used.'"

The NTMA states that the "alligator texture" seems to appear to be in high-volume traffic areas "which we would assume get more maintenance." Also, the MSDS of the cleaning solutions contains a solvent that "could cause deterioration of the terrazzo finish."

5 RECOMMENDATIONS

The NTMA recommends to "Remove the existing membrane and terrazzo where it has debonded and adjacent questionable areas. remove the existing non-conforming underlayment. Install new underlayment meeting NTMA Guidelines. Install new membrane, and terrazzo surfaces." The NTMA also requested more research be done on the cleaning solutions that have been used on maintaining the terrazzo flooring system.

V NIAGARA TERRAZZO INSPECTION REPORT- DATED APRIL 8, 2003 (CONSULTANT HIRED BY CROCETTI)

1 TERRAZZO INSPECTION

Niagara's inspector, Fritz Iselin, Director of Niagara Research, toured Baruch Site 'B' on Thursday, March 13, 2003. He discussed the installation of TEC's 3/8" nominal thickness Tufflite over flex-epoxy membrane. His understanding of the concerns are "random audible hollowness," some debonding and "appurtenant protrusions (primarily along the zinc divider strips)" along with surface failures called "alligating or embossing."

Mr. Iselin states that Crocetti's position is that none of the surface (alligating) or protrusion (zinc strips) deformations were noted or reported until after the building opened to the College students in the fall of 2001. The inspector states that in most cases the "alligating appears as sublimated epoxy binder compared to surrounding 'proud' marble chips—in a few other instances, the chips appear eroded or lower than adjacent epoxy matrix.

Mr. Iselin commented on Testwell Laboratories' first report (3/5/03), noting that "several people noticed odor of solvent when sample pieces were removed," and that all failures appeared between the epoxy membrane and substrate. He advised that "fluids are probably intruding the terrazzo along the micro fissures adjacent to the zinc divider strips, thus the high alkali concentration mentioned in Testwell's summary." Finally, he states that the terrazzo shrinkage warrants further investigation and "in overlays generally are manifest as cracks or open fissures."

Niagara stated that Crocetti "had strongly recommended to Trataros and TDX the use of *MapeCem* hydraulic composite or equal composite as retro-underlayment prior to the terrazzo installation." TDX was never notified of this recommendation.

Mr. Iselin also goes on record that a different subcontractor, other than Crocetti, installed Conflow, and that the lifts for the self-leveling compound varies from "feathered edge" to 1.5 inches thick. Finally, the report notes that the cementitious terrazzo at the stairs and landings, also installed by Crocetti and where no Conflow was placed, remain intact. TDX notes that the terrazzo at the stairs and landings are cementitious terrazzo and not epoxy terrazzo.

2 SUMMARY

The Niagara report states that the terrazzo work generally meets NTMA standards—"except for the post installation curling noted above, the flatness of plane spanning 10 feet is within ¼" variation, the zinc divider strips are true in alignment." The aesthetics of the final product of the terrazzo flooring system is very good. Regarding functionality, the terrazzo is good "excepting the curling-'peaked' corners or edges of panels that might become a trip hazard."

The Niagara report goes on to state that cleaning products used to maintain the floors should warrant further investigations, "especially high speed burnishing causing heat sync, any strong solvents containing solutions." Under a 30x microscope, the "white epoxy in the matrix between marble chips appears to be 'crazed' or almost like 'mud cracking' of a dry riverbed—this is often a sign of severe physical or chemical exposure." The report further states, however, that if maintenance reagents WaterThane400 and PRO general Purpose Cleaner are used at the proper dilutions that "they are suitable for this terrazzo." The PRO does not have "noticeable solvent odor in concentrated liquid form." However, "deterioration or erosion of the chips to a plane below the surrounding epoxy resin—usually a corrosion attack on the mineral composition, such as strong acidic reagents." The report also states that Crocetti performed its work according to the contract documents.

3 THE CONCLUSIONS (NIAGARA RESEARCH)

The Niagara report states that the terrazzo that has hollow spots and "peaked" edges at the zinc strips still hold "a very well bonded audible response" in the center of each panel. The grout injections to rebond the hollow spots wasn't "significantly effective" in treating the repair areas prior to the terrazzo investigations. The report also states there is little recourse but to remove and replace the existing terrazzo flooring and "any suspect underlaying layer(s) of Conflow down to the structural slab." Niagara also recommends two (2) different types of material to use during the installation of the new underlayment. Subject to the terrazzo manufacturer's approval, an epoxy mortar or polyacrylate latex fortified Portland cement composite.

In closing, the report states: "The assured compatibility in writing by the manufacturers of each phase is critical." It is noted that neither TDX, KPF nor DASNY received notification (written or otherwise) which indicated any problems with earlier phases of work (underlayment).

VI RECOMMENDATION OF REMEDIAL WORK:

All work with regard to terrazzo and self-leveling underlayment was the responsibility of Trataros Construction, Inc., under General Construction Contract No. 16 - GC-2:

1. The flooring specialty contractors were both subcontractors to Trataros Construction, Inc.
2. The selection and submission of Conflow as a self-leveling underlayment product was chosen by Trataros Construction and its specialty subcontractor.
3. The contractor was paid \$722,724.80 under change order No. GC2-028 to prepare the floor slabs and install the Conflow material at terrazzo flooring locations throughout the building.

Trataros Construction, Inc., as the General Contractor was responsible to ensure that the correct underlayment was submitted and installed. The preliminary conclusion indicates that the underlayment submitted was not appropriate and furthermore the preparation of the concrete floor did not remove all the curing compound in areas to receive epoxy flooring as required in the contract documents. The investigation was not conclusive on the issue of alligatoring and pitting of the epoxy surface. The investigation also indicated that one sample showed delaminating of the concrete floor due to over troweling. Notwithstanding the last issues that require further investigation, it is in our opinion that Trataros Construction and their subcontractors are responsible for the cost that will be incurred in replacing the floor.

The NTMA is recommending that all terrazzo that has debonded and all areas that have non-conforming underlayment be removed and be replaced. It must be noted that the re-installation of epoxy terrazzo in an occupied building will be extremely costly and will cause significant disruptions to the operation of the facility. It is our recommendation that an alternate flooring material be considered as substitution for epoxy terrazzo replacement. A short-term solution may involve mechanically fastening the terrazzo to the concrete floor.

Very truly yours,
TDX Construction Corporation

John McCullough for Ray Leu

Ray Leu
Project Manager

JOG/

cc: Nick D'Ambrosio - DASNY, Anil Raut - DASNY
James H Jones - TDX, John McCullough - TDX, Jim R. Jones - TDX
File